2301 NTIS Tech Notes
(1990)Apr Springfield, VA, US

G01L 31/28N
G01R 19/00

National Aeronautics and
Space Administration

Brief

Licensing Opportunity

NASA's Jet Propulsion Laboratory, Pasadena, California

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Hall-Effect Current Sensors for Integrated Circuits

Built-in devices would measure direct or alternating currents.

Microscopic Hall-effect sensors may eventually be built into integrated circuits to control and measure electrical currents. Preliminary design studies and experiments with macroscopic commercial Hall-effect sensors have been conducted to assess the feasibility, limitations, and need for further research and development of this concept. Potential applications include programmable power supplies and protective circuitry.

The basic principle of Hall-effect current sensing is well established. The Hall-effect sensor measures the magnetic field at a fixed position near a conductor, and the known proportionality (a function of geometry) between the magnetic field and the current in the conductor is used to infer the current. Although this basic principle is straightforward and fairly simple to apply in the case of large conductors carrying large currents and spaced far apart, several additional factors must be considered in miniaturization.

To concentrate the magnetic field sufficiently to obtain adequate sensor output, the conductor has to be constricted near the sensor, allowing the placement of the sensor close to the centerline (see figure). The length and width of the constriction and the configuration of the conductor at the approach to the constriction have to be chosen not only to accommodate the sensor but also to avoid excessive voltage drop, dissipation of power, and heating. In addition, the current density in the constriction must not be so high as to cause diffusion of the conductor atoms.

A two-sensor, differential scheme is preferred because it can reduce the sensitivity to the magnetic fields caused by currents in other conductors, which one is not seeking to measure. This, in turn, facilitates miniaturization by permitting the closer placement of conductors without excessive degradation of accuracy in the measurements. The differential scheme can also suppress even-order nonlinearities and thermal drifts in the individual sensors.

The maximum frequency at which accurate measurements can be made depends in part on the skin effect, which increasingly affects the distribution of current in the conductor as the frequency increases. An order-of-magnitude calculation shows that frequency distortion could be a significant issue in large sensors but not in monolithic sensors of currents of the order of 1 A. Other issues to be considered in development and design include the responses to transient currents and the need for electrostatic shielding to reduce capacitive coupling of transient voltages to the sensors.

This work was done by Wally E. Rippel of Caltech for **NASA's Jet Propulsion Laboratory.**

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In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

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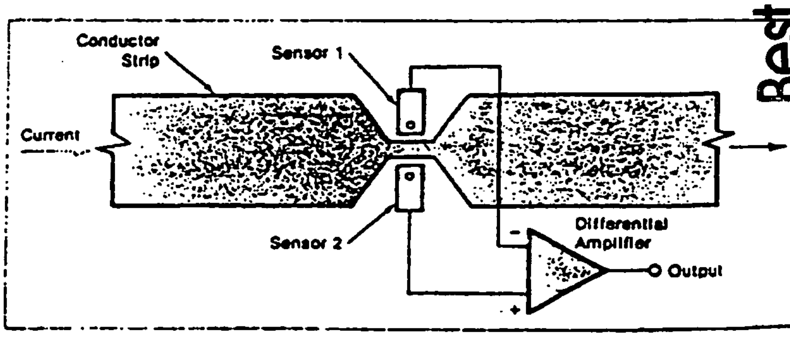

Hall-Effect Sensors are placed near a constriction in a conductor strip. The differential configuration reduces the effects of stray magnetic fields, nonlinearities, and changes in temperature.

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REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

FOR 10/019806